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Evaluation of Alternative Collection and Treatment Methods for Three Small Kansas Communities

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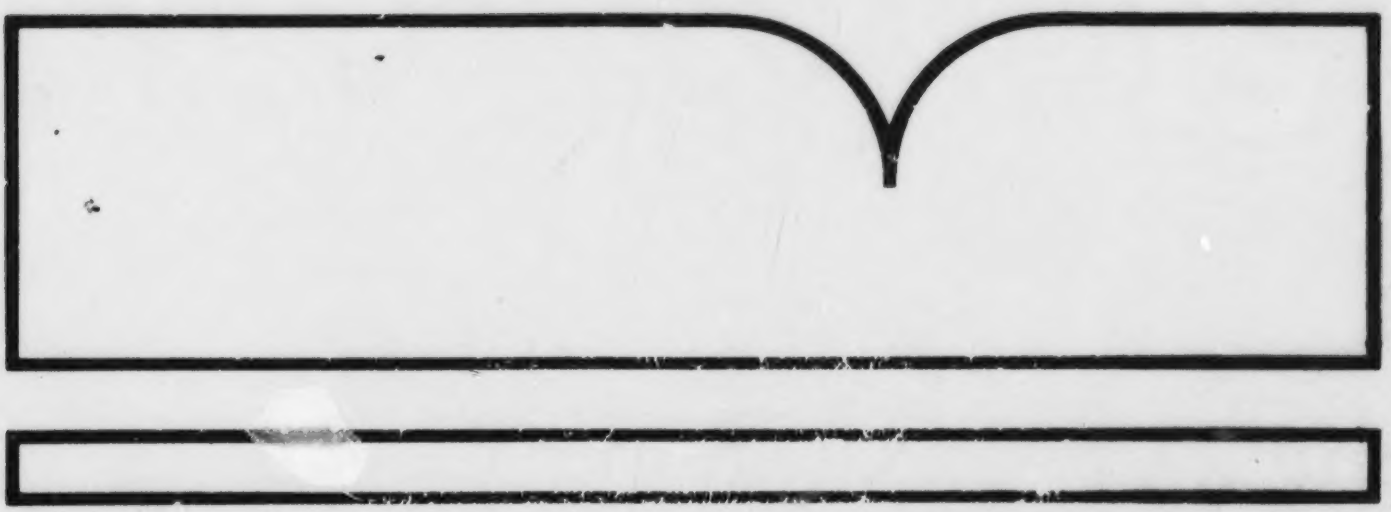

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16. ABSTRACT

This report documents an evaluation of nonconventional alternative wastewater management technologies for three small communities in Kansas. When this evaluation was initiated, all three communities had applied for construction grants, and had had facility plans prepared. In the original facility planning effort, "alternative technologies," as defined by the Clean Water Act of 1977, were not fully considered.

This study included an assessment of existing onsite system performance and a cost-effectiveness analysis of several alternative systems for each community. Present worth costs and annual user costs were developed. Recommendations are offered based on the analysis of technical feasibility, cost-effectiveness, economic impact, and operational implementability.

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EVALUATION OF ALTERNATIVE WASTEWATER COLLECTION AND TREATMENT METHODS FOR THREE SMALL KANSAS COMMUNITIES

by

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This study was conducted
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U.S. Environmental Protection Agency
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FOREWORD

The Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment of public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research; a most vital communications link between the research and the user community.

With passage of the Water Pollution Control Act Amendments of 1977, greater emphasis has been placed on consideration of less costly, decentralized wastewater handling technologies for rural communities. Although widespread utilization and extensive research have demonstrated the technical and economic feasibility of such alternatives, too often these options are not given full consideration in actual facility planning studies. This document presents an analysis of alternative technologies applied to three small communities where facility plans are under review. The study attempts to identify the interrelated technical, economic, and political issues which affect a small community's choice of a wastewater management facility.

Francis T. Mayo
Director
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Research Laboratory

ABSTRACT

This report documents an evaluation of nonconventional alternative wastewater management technologies for three small communities in Kansas. All three communities have applied for construction grants, and have had facility plans prepared. In the original facility planning effort, "alternative technologies," as defined by the Clean Water Act of 1977, were not fully considered.

The study conducted included an assessment of existing on-site system performance and a cost-effectiveness analysis of several alternative systems for each community. Present worth costs and annual user costs were developed. Recommendations are offered based on the analysis of technical feasibility, cost-effectiveness, economic impact, and operational implementability.

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LIST OF ABBREVIATIONS

ABBREVIATIONS

ET	-- evapotranspiration
GP	-- grinder pump
SAS	-- soil absorption system
ST	-- septic tank
STEP	-- septic tank effluent pump

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Many individuals and agencies offered significant contributions during the course of this study. Bob Steiert, Mark Hefner, Don Sandifer, Lyn Harrington, and Jerry Anderson of U.S. EPA Region VII in Kansas City were involved in various phases of the project. Mark Hefner and Don Sandifer in particular showed special interest in the study, and participated in several field visits. John Metzler, with the Kansas Department of Health and Environment, was also very cooperative, and accompanied us in our visits to the communities. LaVene Brenden, Karl Mueldener, and Paul Gassman, also of the Department of Health and Environment, provided technical reviews and offered constructive comments.

Al Reiss and Maurice Dingler of Reiss and Goodness Engineers were very helpful in providing information related to the three facility plans, and in arranging the field visits. Conversations with Al Reiss provided much insight gained from his many years of experience in working with small rural communities.

Finally, Bob Bowker and Jim Kreissl provided technical review and project direction on behalf of the U.S. EPA Municipal Environmental Research Laboratory in Cincinnati.

SECTION 1

INTRODUCTION

The objective of this study is to assess the feasibility and applicability of on-site systems and alternative collection systems to serve the wastewater management needs of three small communities in Kansas. The purpose is not only to evaluate specific alternatives for these three communities, but also to illustrate the range of alternative technologies that might apply to other communities similar to these. The technical questions and issues addressed in this report are basically relevant to any small community involved in facilities planning. Although the specific socioeconomic factors and physical characteristics discussed might not apply in other situations, the approach taken in dealing with these factors in the evaluation of alternatives is valid in any case.

The major output of this study is the evaluation of alternatives, presented separately for Furley, Corning, and Havana, Kansas in Section 2 of this report. This evaluation of alternatives includes recommendations suggesting appropriate technical alternatives and necessary management programs. Other sections of the report describe the background of the three projects, and present an overall assessment of technical, socioeconomic, and environmental issues to be considered.

The three communities selected for this study are Corning, Furley, and Havana. All three are located in Kansas. Corning is approximately 50 miles northwest of Topeka, Furley is about 20 miles northeast of Wichita, and Havana is about 15 miles southwest of Independence, Kansas. Corning, Furley, and Havana all have populations less than 200, and are rural, agriculturally-oriented communities. Both Corning (population: 152) and Havana (population: 184) are Class 3 cities under Kansas statutes. While Furley (population: 97) is not an incorporated city, an improvement district has been established to be responsible for providing wastewater service to the community.

Facilities planning has been initiated for all three communities, and Step I facility plans have been prepared. These facility planning efforts began in 1977 generally as a result of reports by County sanitarians or District geologists

(employed by Kansas Department of Health and Environment -- KDHE) which cited "poorly drained" soils with "extremely low" permeability in all three cases. Realizing that "alternative" wastewater management technologies (as defined by EPA PRM 79-8) might be applicable, U.S. EPA Region VII requested the Municipal Environmental Research Laboratory (MERL) to sponsor a study addressing the feasibility of alternative systems in these three communities.

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SECTION 2

EVALUATION OF ALTERNATIVES

GENERAL ASSESSMENT

The issues which will be considered in the evaluation of alternatives fall into three major categories:

- Technical.
- Socioeconomic.
- Environmental.

Technical Issues

Soil suitability is obviously a key technical issue since it affects the feasibility of on-site systems and other alternatives, such as land application. Based on discussions with local sanitarians and District geologists, and on gross observations during field visits, soil characteristics were confirmed to be essentially as stated in the facility plans (i.e., slowly permeable and unsuitable for septic tank systems). Due to the widespread occurrence of silty clay soils in the upper horizons, and the presence of underlying clay, even modified on-site systems such as sand mounds are not viable since lateral, as well as vertical, soil water movement is restricted. Soil testing (i.e., test pit observations and percolation tests) may indicate individual sites within the three communities have suitable soils, but on a community-wide basis individual on-site systems do not appear feasible. Soils information for the three communities supporting this conclusion is summarized in Appendix A. The feasibility of individual on-site systems is further limited by relatively small lot sizes (typically less than one-half acre in Corning and Havana, and less than 10,000 square feet in Furley).

Bedrock and groundwater in these areas are generally deep, and do not represent a problem affecting either sewer construction or subsurface disposal systems. Surface ponding and surface breakouts are caused more by water (surface runoff from rainfall or sewage effluent) perched over impermeable clay soil layers, than by rising groundwater table.

Land is available for either lagoon facilities or land application sites in close proximity to the three communities, since all three are isolated and surrounded by land either under cultivation or used for other agricultural purposes. The soil characteristics for lands which might be used for land application (within one-half mile of the community) are discussed in Appendix A.

Discharge limitations would apply to any surface-water discharge. Discharging lagoons such as those proposed have been generally approved by KDHE. This implies that standard discharge limitations applying to lagoon discharges are adequate.

The performance and reliability of nonconventional collection methods being considered is obviously an important technical issue. Actual operating experience is the best measure of performance and reliability. Research by U.S. EPA and other institutions has documented such experience[1,2,3] and established that both pressure sewer systems (septic tank effluent pumps and grinder pumps) and small diameter gravity systems can be designed and constructed to meet generally acceptable performance standards. To further document operating experience with such systems, a list of communities throughout the country presently operating alternative collection systems is presented in Appendix B. In some cases, these systems have been operational for up to 10 years.

Socioeconomic Issues

The cost-effectiveness of various alternative systems, as compared to the conventional wastewater systems proposed in the facility plans (see Table 1), will be investigated specifically for each community in the following section of this report. That analysis will be concerned primarily with alternative collection systems, since lagoons are generally accepted by the

[1]"Alternatives for Small Wastewater Treatment Systems," Volume 2, U. S. EPA Technology Transfer Publication, October 1977.

[2]Kreissl, J.F., "Status of Pressure Sewer Technology," U. S. EPA Municipal Environmental Research Laboratory, 1976.

[3]"The Westboro Waste System: A Solution For Small Communities (Small Diameter Gravity Sewers)," University of Wisconsin Agricultural Extension Service.

TABLE 1. ESTIMATED COSTS OF PROPOSED FACILITIES IN 1979 FACILITY PLANS[1]

	Corning	Furley	Havana
Construction Cost			
Treatment System	53,749	71,845	39,997
Collection System	326,097[5]	144,852[5]	208,308[5]
	379,846	216,697	248,305
Total Capital Cost[2]	493,512	295,597	328,040
(Cost Per User)	(5,483)	(9,535)	(4,260)
Possible Grants			
EPA	308,416	195,876	201,101
HUD	164,468	--	112,690
FmHA	92,553	--	63,344
Local Share			
EPA Grant	185,106	99,721	126,939
EPA/HUD Grants	20,637	--	14,324
EPA/FmHA Grants	92,553	--	63,595
O&M Cost $/year	2,100	950	2,100
(Cost Per User $/year)	23	31	27
Total Annual Cost Per User[3]			
EPA Grant	217	304	183
EPA/HUD Grant	45	--	45
EPA/FmHA Grant[4]	83	--	75

[1] Cost of recommended alternatives (gravity sewers and lagoons) as presented in Facility Plan Reports prepared by Reiss and Goodness Engineers.

[2] Including land, R.O.W., engineering fees, legal fees, etc.

[3] Assuming private financing of local share of capital cost at 7% over 20 years.

[4] Assuming FmHA financing of local share of capital cost at 5% over 40 years.

[5] Including house connection costs.

State (KDHE) as the most appropriate and cost-effective treatment process for small communities such as these. In addition, the cost for wastewater collection was 70-85% of the total project cost.

Aside from developing present worth costs for the purpose of cost-effectiveness evaluations, annual user costs will be estimated. These estimates represent each user's equal share of capital and operating costs after subtracting grants. Construction grants from EPA, HUD, and FmHA can conceivably be applied to subsidize up to 96 percent of the total capital cost. In addition to this, it may be possible to apply certain tax support programs such as the Homestead Tax Relief Act in Kansas to further subsidize user costs when ad valorem taxes are used to recover capital costs. Based on a review of this act, it appears that "special assessments" would not be eligible for tax relief; however, a legal opinion is probably needed to determine whether the cost of sewerage facilities can be subsidized through tax relief in this case.

In any case, it is apparent that various forms of subsidies can be applied to significantly reduce the effective cost to the user. As a result, potential users do not seem concerned about the cost of the conventional wastewater systems proposed. Because of this, there is little incentive in the general public's view to pursue innovative alternatives which may involve greater risk to achieve cost savings. This attitude adds to the public's inherent skepticism toward nonconventional wastewater systems.

There is also the legitimate concern that small rural communities may not be capable of operating the alternative systems being considered on a day-to-day basis. Although limited manpower resources might affect the maintenance of these systems, it should also be a consideration in the case of conventional system maintenance, especially when pump station maintenance would be involved, such as in Havana and Corning. The maintenance activities required for the pressure sewer systems are fairly straightforward, and could be easily fulfilled by a mechanically-inclined, part-time employee. Special skills and training would not be required, given proper direction by the design engineer and equipment manufacturer representatives. For confirmation of actual maintenance requirements, reference is again made to the list of operating systems given in Appendix B.

Environmental Issues

Surface water and groundwater quality impacts resulting from existing conditions are not as serious as the public health threat due to surface ponding of septic tank effluent.

Public water systems serve all three communities; therefore, drinking water contamination is not a threat. The conveyance of effluent to surface waters via drainage ditches does result in some direct discharge of sewage to streams, however, most of the effluent remains standing in ditches until it eventually infiltrates the soil or evaporates. This condition will be eliminated with the installation of either the conventional or alternative collection systems being considered.

Only minor aesthetic impacts are expected to be associated with the collection and treatment systems (e.g., lagoon odors during times of freezing and thawing). Secondary impacts such as stimulated community growth are not expected, although some potential for increased development does exist for Furley due to its proximity to Wichita.

COMPARISON OF ALTERNATIVES

Several technical options for collection and treatment were explored to determine their general applicability to the communities in question. These options fall into three categories:

1. Individual systems.
2. Alternative collection systems.
3. Alternative treatment systems.

The purpose of evaluating these general categories of treatment and collection options is to screen out alternatives which appear to be technically unfeasible.

Individual Systems

Due to the poor soil characteristics in all three communities, most conventional septic tank-soil absorption systems (ST-SAS) are not feasible. Soil absorption of treated wastewater is dependent on good permeability. The clay soils in these areas are highly impermeable (see Appendix A).

The unsuitability of soil conditions in these three communities is further documented by the reports of KDHE District geologists and county sanitarians. These reports were confirmed by personal communication with the technical staff of these agencies. Detailed sanitary surveys, involving house-to-house investigations of system failures, were not considered warranted since our field visits and interpretations of soil survey data (supplemented by discussions with Kansas SCS personnel) supported the earlier findings that physical conditions preclude the use of conventional on-site systems in all three communities.

This also applies to any variations in on-site system design, such as elevated sand mound disposal areas which ultimately rely on subsurface disposal.

An on-site system which is not dependent on subsurface disposal may be applicable. Evapotranspiration (ET) is one such disposal method. Evaporation of moisture from the soil surface or transpiration by plants is the mechanism of ultimate disposal. In areas where the annual evaporation rate exceeds the rate of annual precipitation, an ET system may be applicable.

A typical ET bed system consists of 1-1/2 to 3-foot depth of sand (uniform diameter = 0.10 mm) over an impermeable plastic liner. The sand is capable of raising water about 3 feet through capillary action, keeping the bed surface moist. Perforated plastic piping is used to distribute septic tank effluent in the bed. For a successful system, pan evaporation must exceed annual rainfall by at least 24 inches.[1] Since this condition is not met in Kansas, evaporation systems were not considered to be technically viable solutions for the study areas.

Another on-site alternative not dependent on soil conditions is the surface discharge system, which typically consists of pretreatment (septic tank or aerobic unit) followed by sand filtration and disinfection. However, because of the high housing densities and limited opportunities for effluent discharge, the on-site surface discharge alternative was not given further consideration as a major solution to the wastewater problems of these small communities.

One innovative on-site system is designed specifically for clay soil conditions such as exist at these three locations. The electro-osmosis subsurface disposal field relies on materials such as coke and graphite to act as electrodes, creating an electrical field across the drainage area which enhances soil water transport. Although such systems have been installed with apparent success,[2] the theory remains unproven. Therefore, the use of such systems should be limited to experimental systems only until their performance is further documented.

---

[1]Environmental Protection Agency, Alternatives for Small Wastewater Treatment Systems: On-Site Disposal/Septage Treatment and Disposal, October 1977.

[2]Richard Prince, Georgetown Divide Public Utility District, Georgetown, California.

Alternate Collection Systems

Several alternatives to the conventional gravity sewer system will be considered. The different types include:

- Small diameter gravity sewers -- 4-to 6-inch diameter sewers used to convey septic tank effluent, as opposed to raw sewage.

- Small diameter pressure sewers -- Pipe as small as 1-1/4 inch diameter, used in conjunction with small individual pump systems at each home; these pumps can be either grinder pumps (to convey raw sewage directly) or effluent pumps (to convey septic tank effluent); the latter system is commonly referred to as a septic tank effluent pump (STEP) system. Variations include serving more than one home with a single pumping unit.

- Vacuum sewers -- Also using small diameter pipe, with a central vacuum source and interfacing valves at each home.

In general, conventional gravity collection methods have been found to be technically feasible and acceptable to local agencies and residents. However, it is possible that the same wastewater service could be provided by one of the alternative systems at a lower cost.

Small diameter gravity sewers are best suited to serving small groups of homes where deep cuts are not required for sewer installation. They are not particularly suited to flat terrain since deeper cuts are necessary to maintain grade. In addition, Kansas state law requires sewer pipe to be at least 8 inches in diameter. This restriction applies to the conveyance of raw sewage, whereas small diameter gravity sewers transport septic tank effluent essentially free of large solids, grease, and scum. An exception to this state code should be considered in such applications.

A pressure sewer system is essentially the reverse of a water distribution system. In water distribution there is a single pressurization point at the inlet and many user outlets, while pressure sewers employ many inlet pressurization units and a single outlet. The two major types of pressure systems are the grinder pump (GP) system and the septic tank effluent pump (STEP) system. These are depicted in Figures 1 and 2, respectively. The major differences between the two are in the on-site equipment and layout. Neither system requires any modification of household plumbing.

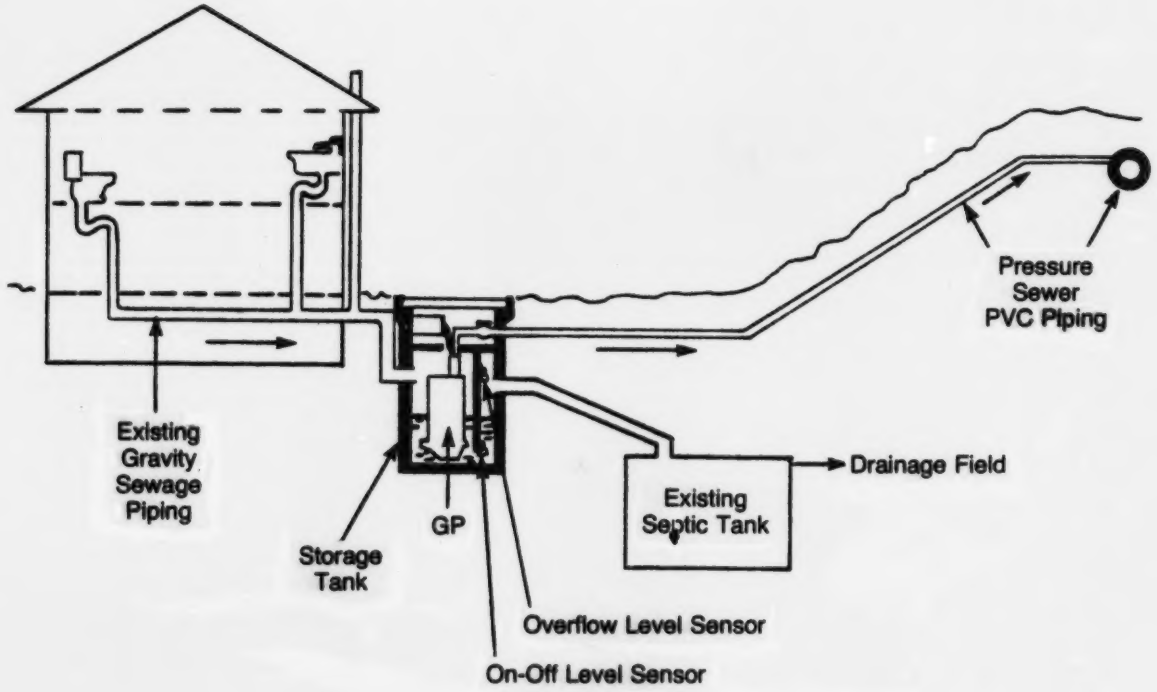

Figure 1. Typical grinder pump installation.

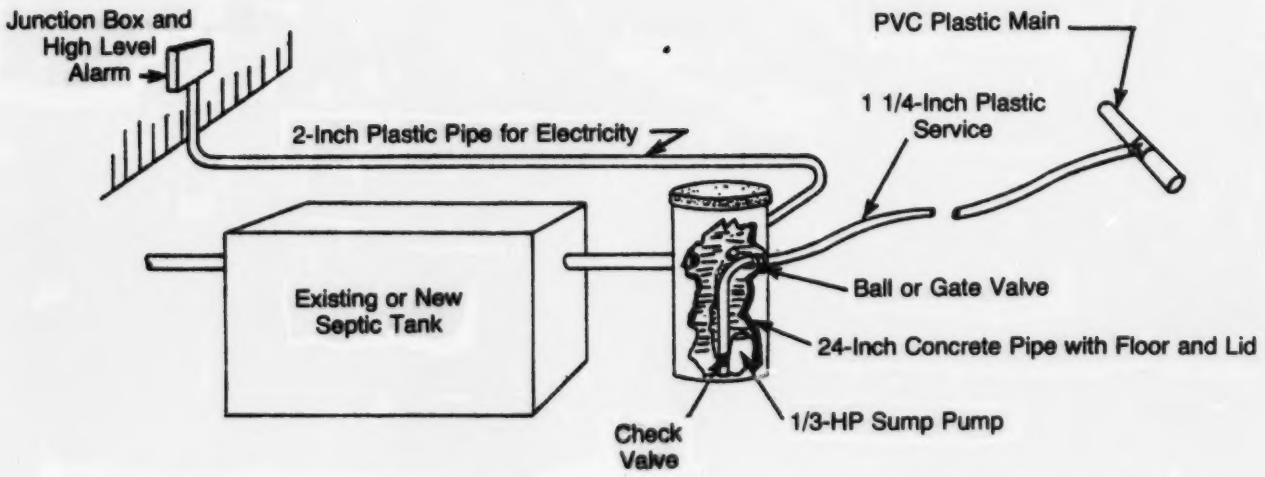

Figure 2. Typical STEP system.

With these systems, household wastes are collected in the building drain and conveyed to the pretreatment or pressurization facility. Each pressurization unit can be isolated from the main sewer by means of valves. Significant treatment of the waste occurs in the septic tank of the STEP system. Removal of up to 80 to 90 percent of the grease, 70 to 90 percent of the suspended solids, and 50 to 70 percent of the bio-chemical oxygen demand is typical. The effluent from the tank flows (by gravity) to a receiving tank, housing a small pump. The effluent is then pumped into the pressure sewers. In the GP system, the septic tank is eliminated and the raw sewage is pumped directly to the treatment facility.

During power outages and other emergency situations, contingency overflow storage is required for either the STEP or GP system. The STEP system has emergency overflow storage "built in" by virtue of freeboard in the septic tank and pump well. To provide equal protection with the GP system, an emergency holding tank may be installed at the time of construction, involving additional costs. The septic tank in the STEP system provides an additional advantage over the GP system. With grease, SS, and BOD removed, the septic tank effluent is not as concentrated as the effluent from the GP system. The more concentrated GP effluent generally results in somewhat higher treatment costs. However, the cost of treating septage (residual solids and scum pumped from the STEP system) must also be considered. The GP effluent would also be expected to deposit more grease and other solids in sewer lines. This may block flow areas and increase sewerline maintenance. The STEP system pump is not as mechanically complex as the grinder pump; therefore, pump maintenance should be simpler and less frequent for the STEP system. The septic tank, which provides many advantages for the STEP system, has the drawback of requiring periodic cleaning to remove the accumulated solids. Table 2 presents a cost comparison for the GP systems and STEP systems. On the basis of this cost comparison and other factors discussed, STEP systems appear to be more appropriate than GP systems in the applications being considered.

Vacuum sewer systems have the advantage of a centralized depressurization unit, but rely on separate vacuum valve devices at each house connection. Therefore, the maintenance of individual units is required in addition to operation of the central vacuum generating unit. The design of the vacuum generating facility and the house connection valves is fairly complex compared to pressure sewer systems, and therefore, requires more sophisticated operation and maintenance techniques. For the purpose of this study, only pressure and gravity sewers were considered since cost and operating data are well documented. In actual practice, all collection alternatives, including vacuum sewers, should be fully evaluated.

TABLE 2. COST COMPARISON GP SYSTEM VS.STEP SYSTEM

Item	Cost	
	GP System	STEP System
Capital Costs		
Pump	1,000 to 2,000(1) 500 to 600(3) 870 (4) 2,100 (5)	200 to 400(1) 200 (3)
Pump, Pump Well and Appurtences	1,300 to 2,700(1) 1,300 to 1,700(3) 1,370 to 2,070(4)	1,200 to 2,400(1) 1,000 to 1,100(3)
Pump System Installed, Including Service Lines		
Glide, Oregon		2,000 (2)
Priest Lake, Idaho		1,000 to 1,200(2)
Port Charlotte and Port St. Lucie, Florida		800 to 1,000(2)
Phoenixville, Pennsylvania	2,050 (1)	
Weatherby Lake, Missouri	1,900 (6)	
Operation and Maintenance (9)	75/year/unit (7)	50/year/unit (7,8)

(1) Environmental Protection Agency Technology Transfer Seminar Publication, Alternatives for Small Wastewater Treatment Systems: Pressure Sewers/Vacuum Sewers, October 1977.

(2) Lodge, Patricia H., Introduction and Design of Pressure Sewer Systems, University of Wisconsin-Extension Program on Pressure Sewer Systems, November 1979.

(3) Bowne, William C., 1979.

(4) Milnes, Tom, Quaker Lake, Pennsylvania, 1978.

(5) Peabody Barnes, 1979.

(6) Engineering Report, Professional Engineer Magazine, Glenn Gray, Larkin and Associates Engineers, June 1975.

(7) The Cost of Small Community Wastewater Alternatives, J.F. Kreissl, R. Smith, J.A. Heidman, USEPA-MERL, August 1978.

(8) Includes septic tank pumping every 4 years.

(9) Pressure sewer line O&M should be higher for GP system than STEP system.

Alternative Treatment Systems

The range of treatment alternatives considered applicable in this case is represented by:

- A package treatment plant system.
- A lagoon with spray irrigation.
- A lagoon with surface discharge.

In the facility plan analysis by Reiss and Goodness, the spray irrigation alternative was considered. Table 3 presents the cost estimates prepared in that analysis. Cost estimates for a package plant alternative from another source have also been included. Although the capital cost of the package plant system is less, the annual operating costs are higher. Because of this, the discharging lagoon system is the least expensive alternative in terms of present worth. The lesser operation and maintenance requirements of the lagoon system also represent an advantage in light of the lack of skilled plant operators in these rural areas. Other alternatives, such as one of various oxidation ditch designs, might be considered to reduce operation and maintenance requirements; however, their cost would still exceed that of the lagoon systems.

Community subsurface disposal systems are not viable due to the soil conditions (i.e., widespread and deep clay soils) discussed earlier. Although surface soil permeabilities might support low rate land application, its high cost, operation and maintenance needs, and inapplicability in freezing conditions rule out this alternative.

Based on this evaluation, discharging lagoon systems are considered the most appropriate treatment alternative. They are both technically feasible and cost-effective.

COST ANALYSIS METHODOLOGY

Several analyses were carried out in order to evaluate the cost effectiveness of each alternative under consideration. These analyses include:

- Construction cost.
- Operation and maintenance cost.
- Present worth analysis.
- Annual user cost analysis.

Construction and O&M Costs

Construction costs and yearly operation and maintenance were determined for each alternative for both present and

TABLE 3. TREATMENT ALTERNATIVE COSTS (1979 $)

Treatment Alternative[4]	Costs			
	Capital ($)		O&M ($/Yr)	
	Total	Per Capita[5]	Total	Per Capita[5]
Package Plant				
Corning	30,000[1]	197	6,800[2]	45
Furley	27,000[1]	278	4,760[2]	49
Havana	33,000[1]	179	7,480[2]	41
Spray Irrigation				
Corning	98,600[3]	649	5,000[3]	33
Furley	98,175[3]	1,012	3,000[3]	31
Havana	72,700[3]	395	3,000[3]	16
Continuous Discharging Lagoon				
Corning	53,749[3]	394	1,500[3]	10
Furley	71,845[3]	857	2,000[3]	21
Havana	39,997[3]	229	1,500[3]	8

[1] "Wastewater Treatment Processes and Systems, Performance and Cost", Roy F. Weston Inc., October 1977. (Costs updated to 1979 $.)

[2] "Package Wastewater Treatment Plant Descriptions, Performance and Cost", prepared for the Department of Housing and Urban Development, Office of Policy Development and Research by SCS Engineers, April 1977. (Costs updated to 1979 $.)

[3] Facilities Plans, Reiss and Goodness Engineers (for Corning, Furley Improvement District and Havana), 1978. (Assumed 1979 $.)

[4] Based on 70 gal/cap/day of wastewater.

[5] Based on 1978 population data in Facilities Plans.

future populations. (Population data are presented in Table 4.) Nonconstruction costs (such as engineering and legal fees) were not included in these cost estimates. Treatment system costs were taken directly from the respective facility plan. Itemized breakdowns of construction and operation and maintenance costs are given for each alternative.

Present Worth Analyses

The present worth analyses were based on construction and O&M costs estimated for service to the future populations. The following assumptions were made for the analyses:

- Planning period = 20 years.
- Interest rate = 7 percent
- Sewer lines and treatment facilities have a service life of 50 years.
- STEP unit components, including the pump and related appurtenances, have a service life of 20 years, while the pump well and piping have a service life of 50 years.
- Pump station components, including pumps and related appurtenances, have a service life of 20 years, while the remaining components have a 50-year service life.
- Land has a salvage value equal to its value at the end of the planning period, assuming the original values appreciate at a rate of 3 percent compounded annually.

Annual User Cost Analyses

The annual cost analyses were based on capital costs (construction plus a fixed percentage for nonconstruction costs) and O&M costs estimated for service to the present populations. In addition, the use of EPA construction grants were assumed to partially subsidize capital costs. The following assumptions were made for the analyses:

- Planning period = 20 years.
- Interest rate = 7 percent

TABLE 4. POPULATION DATA

Community	Present			Future		
	No. of Units	Population	Density (persons/home)	No. of Units	Population[1]	Density[2] (persons/home)
Corning	105	152	1.45	124	208	1.68
Furley I	40	97	2.43	55	140	2.55
Furley II[3]	40	97	2.43	165	500	2.99
Havana	75	184	2.45	87	220	2.53

[1]Source: Reiss and Goodness reports.

[2]Assumes 3 persons/unit in new construction.

[3]An additional higher future population projection was considered to illustrate the impact of potential growth.

- EPA grants = 85 percent of eligible costs for the alternative collection systems, and 75 percent of eligible costs for conventional collection and treatment systems (lagoons are considered conventional treatment systems).

ALTERNATIVE SYSTEMS FOR CORNING

Three alternative systems are evaluated for the Corning service area:

- Alternative I -- Small diameter pressure sewer collection system utilizing individual septic tank effluent pump (STEP) units (i.e., one per user), as well as clustered STEP units (one pumping unit serving two or more homes), and a continuously discharging lagoon treatment facility.

- Alternative II -- Small diameter gravity sewer collection system with individual septic tanks, and a continuously discharging lagoon.

- Alternative III -- Conventional gravity sewer collection system and a continuously discharging lagoon.

Small diameter gravity sewers are considered in this case, due to the moderately sloping terrain of Corning. In all cases the lagoon treatment facility would be located south of the City as proposed in the facility plan. The alternative collection systems are shown in Figure 3.

Construction and O&M costs are presented in Tables 5 and 6 for both present and future (20 years) population estimates. The present worth costs for the three alternatives are presented in Table 7. These estimates reflect the total construction costs (not including engineering/legal fees, etc.) and operating costs of facilities serving the future design population. The annual cost estimates presented in Table 8 reflect the total capital costs (including engineering/legal fees, etc., and financing of local shares), and operating costs for facilities serving the present population. It is assumed that the cost of individual STEP units, service lines, and house connections for future homes will be absorbed in the cost of the house, and should not be included in the user cost.

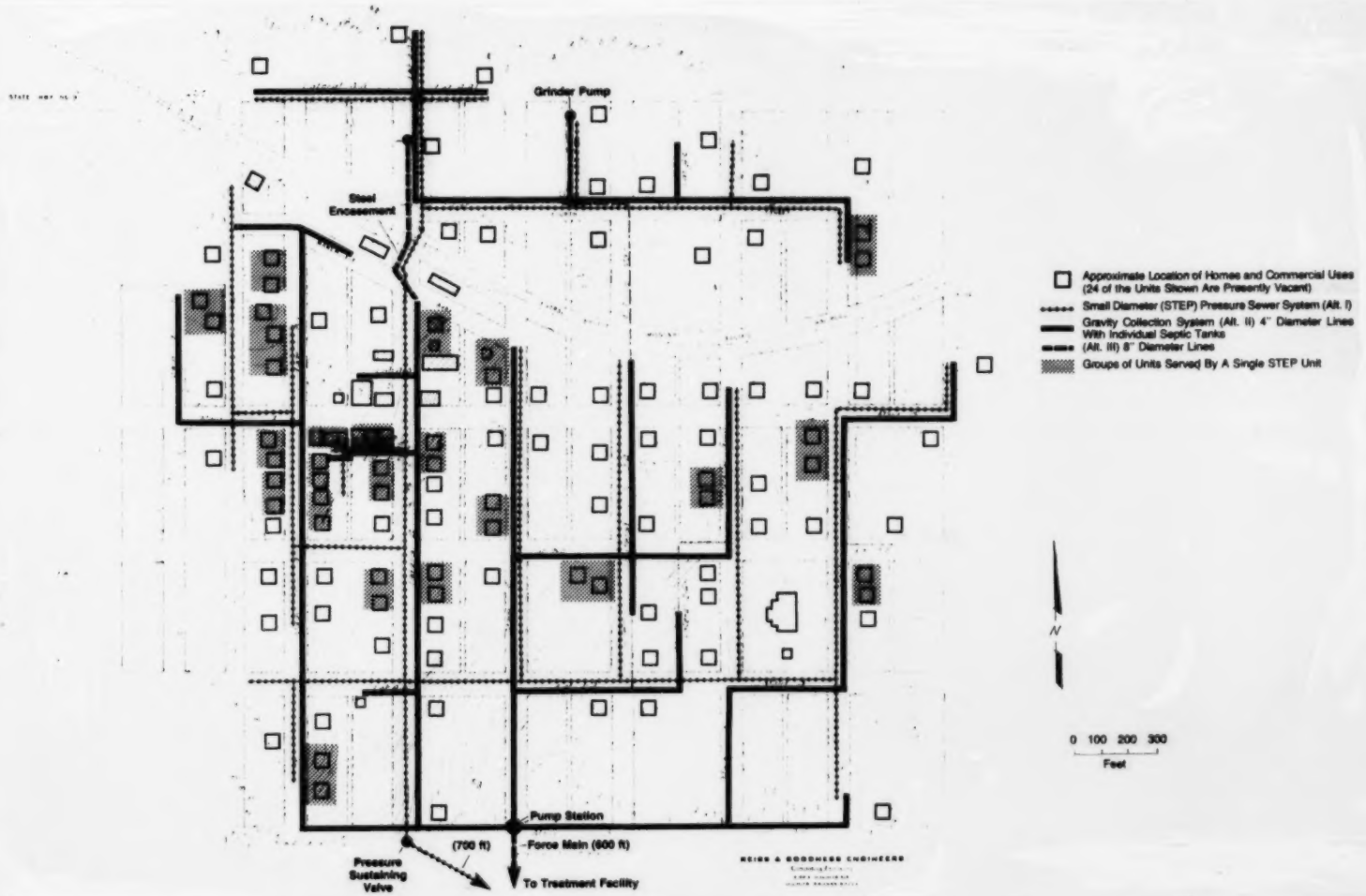
Grinder Pump
Steel Encasement
Approximate Location of Homes and Commercial Uses (24 of the Units Shown Are Presently Vacant)
Small Diameter (STEP) Pressure Sewer System (Alt. I)
Gravity Collection System (Alt. II) 4" Diameter Lines With Individual Septic Tanks
(Alt. III) 8" Diameter Lines
Groups of Units Served By A Single STEP Unit
N
0 100 200 300
Feet
Pump Station
Force Main (600 ft)
(700 ft)
Pressure Sustaining Valve
To Treatment Facility

Figure 3. Collection system alternatives for Corning.

TABLE 5. CONSTRUCTION COSTS[1] -- CORNING (1979 $)

ALTERNATIVE	ITEM	UNIT COST $	PRESENT POPULATION - 105 DWELLINGS QUANTITY	PRESENT POPULATION - 105 DWELLINGS COST $	FUTURE POPULATION - 124 DWELLINGS QUANTITY	FUTURE POPULATION - 124 DWELLINGS COST $
I	1-1/2" PVC Sewer Line	3.75/ft.	6400 ft.	24,000	6400 ft.	24,000
	2" PVC Sewer Line	4.00/ft.	4000 ft.	16,000	4000 ft.	16,000
	2-1/2" PVC Sewer Line	4.25/ft.	3900 ft.	16,575	3900 ft.	16,575
	3" PVC Sewer Line	4.75/ft	2900 ft.	13,775	2900 ft.	13,775
	4" PVC Sewer Line	5.50/ft.	1300 ft.	7,150	1300 ft.	7,150
	6-5/8" Steel Encasement[2]	30.00/ft	115 ft.	3,450	115 ft.	3,450
	STEP Units (Septic Tank, Pump, & Pump Well)	1300 each	80[7]	104,000	94[9]	122,200
	Septic Tanks	400 each	25[8]	10,000	30[8]	12,000
	Service Lines (1-1/4" PVC)[3]	3.00/ft.	13400 ft.	40,200	15750 ft.	47,250
	COLLECTION SYSTEM TOTAL			235,150		262,400
	House Connection[4]	50 each	105	5,250	124	6,200
	Treatment Facility (Discharging Lagoon)	(see Note 5)	1	42,218	1	42,218
	TOTAL CONSTRUCTION COST			282,618		310,818
	Land	1200/acre	4 acres	4,800	4 acres	4,800
II	4" Gravity Sewer Line	15.00/ft.	19100 ft.	286,500	19100 ft.	286,500
	4" Force Main	5.50/ft.	1100 ft.	6,050	1100 ft.	6,050
	6-5/8" Steel Encasement[2]	30.00/ft.	115 ft.	3,450	115 ft.	3,450
	1-1/2" PVC Sewer Line	3.75/ft.	300 ft.	1,125	300 ft.	1,125
	Pump Stations	(see Note 6)	2	40,000	2	40,000
	Grinder Pump Unit	1750 each	1	1,750	1	1,750
	Septic Tanks	400 each	105	42,000	124	49,600
	Service Lines (4" PVC)[3]	5.00/ft.	15750	78,750	18600 ft.	93,000
	COLLECTION SYSTEM TOTAL			459,625		481,475
	House Connection[4]	50 each	105	5,250	124	6,200
	Treatment Facility (Discharging Lagoon)	(see Note 5)	1	42,218	1	42,218
	TOTAL CONSTRUCTION COST			507,093		529,893
	Land	1200/acre	4 acres	4,800	4 acres	4,800

TABLE 5. (CONTINUED)

	8" Gravity Sewer Line	20.00/ft.	19100 ft.	382,000	19100 ft.	382,000
	4" Force Main	5.50/ft.	1100 ft.	6,050	1100 ft.	6,050
	6-5/8" Steel Encasement (2)	30.00/ft.	115 ft.	3,450	115 ft.	3,450
	1-1/2 PVC Sewer Line	3.75/ft.	300 ft.	1,125	300 ft.	1,125
III	Pump Stations	(see Note 6)	2	40,000	2	40,000
	Grinder Pump Unit	1750 each	1	1,750	1750	1,750
	COLLECTION SYSTEM TOTAL			434,375		434,375
	Service Lines (4" PVC) (3)	5.00/ft.	15750	78,750	18600 ft.	93,000
	House Connection (4)	50 each	105	5,250	124	6,200
	Treatment Facility (Discharging Lagoon)	(see Note 5)	1	53,749	1	53,749
	TOTAL CONSTRUCTION COST			572,124		587,324
	Land	1200 acre	6 acres	7,200	6 acres	7,200

NOTES (TABLE 5)

1. Construction costs do not include engineering fees, legal fees, contingencies, or land costs (land costs are shown separately).

2. Steel encasement installed by boring required for railroad crossing.

3. Service line includes line from house to street lateral in a gravity system, and the line from the septic tank or pumping unit to the street lateral for the STEP or small diameter gravity sewer systems. Assume 150 feet per single connection and 100 feet per home in a cluster connection.

4. Connection to house plumbing; includes labor only for gravity sewer systems and includes labor plus 4" connection line to septic tank for STEP system.

5. Lagoon costs based on Reiss and Goodness estimate in facility plan; a 50% reduction in lagoon size was assumed in Alternatives I and II to account for solids removed in septic tank.

6. Pump station costs based on Reiss and Goodness estimates.

7. Assuming 22 clustered STEP units serving two or three homes each (see Figure 3).

8. Additional tanks for homes connected to a cluster STEP unit (each home has an individual septic tank).

9. Assuming 27 clustered STEP units.

TABLE 6. OPERATION AND MAINTENANCE COSTS -- CORNING (1979 $)

ALTERNATIVE	ITEM	UNIT COST $/YR	PRESENT POPULATION QUANTITY	PRESENT POPULATION COST $/YR	FUTURE POPULATION QUANTITY	FUTURE POPULATION COST $/YR
I	Pressure Sewer Lines	100/mile	18,500 ft.	350	18,500 ft.	350
	STEP units (1)	45/unit	80	3,600	94	4,230
	Septic Tank Pumping (2)	15/unit	105	1,575	124	1,860
	Treatment Facility	(see Note 3)	1	1,500	1	1,500
	TOTAL			7,025		7,940
II	Gravity Sewer Lines	500/mile	19,100 ft.	1,810	19,100 ft.	1,810
	Force Main	100/mile	1,100 ft.	20	1,100 ft.	20
	PVC Pressure Sewer Line	100/mile	300 ft.	5	300 ft.	5
	Pump Stations	800 each	2	1,600	2	1,600
	Grinder Pump	75/unit	1	75	1	75
	Septic Tank Pumping (2)	15/unit	105	1,575	124	1,860
	Treatment Facility	(see Note 3)	1	1,500	1	1,500
	TOTAL			6,585		6,870
III	Gravity Sewer Lines	500/mile	19,100 ft.	1,810	19,100 ft.	1,810
	Force Main	100/mile	1,100 ft.	20	1,100 ft.	20
	PVC Pressure Sewer Line	100/mile	300 ft.	5	300 ft.	5
	Pump Stations	800 each	2	1,600	2	1,600
	Grinder Pump	75/unit	1	75	1	75
	Treatment Facility	(see Note 3)	1	1,500	1	1,500
	TOTAL			5,010		5,010

NOTES (TABLE 6)

1. STEP unit O&M costs distributed as follows:

Power	-	3.00/yr.
Pump Repair	-	20.00/yr.
Preventive Maintenance	-	12.00/yr.
Appurtenance Repair	-	10.00/yr.
		45 $/yr.

2. Assuming tank pumped once every four years at a cost of $60.00 per pumping which includes the cost of transporting and disposal.

3. Operation and maintenance costs based on Reiss and Goodness estimate for typical small lagoon.

TABLE 7. PRESENT WORTH COST (BASED ON FUTURE POPULATION) -- CORNING (1979 $)

ITEM	DOLLARS ALTERNATIVE I	ALTERNATIVE II	ALTERNATIVE III
Total Construction Cost	310,818	529,893	587,324
Present Worth of Construction Cost (x1.00)	310,818	529,893	587,324
Land Cost	4,800	4,800	7,200
Present Worth of Land Cost (x 1.00)	4,800	4,800	7,200
Salvage Value of Collection System[1]	84,120	263,835[6]	291,375[6]
Salvage Value of STEP Units[2]	50,760	600[7]	600[7]
Salvage Value of Pump Stations[3]	------	7,920	7,920
Salvage Value of Treatment Facility[4]	25,330	25,330	32,250
Salvage Value of Land[5]	8,670	8,670	13,000
TOTAL SALVAGE VALUE	168,880	306,355	345,145
Present Worth of Total Salvage Value (x 0.2584)	(43,640)	(79,160)	(89,185)
Total Operating Cost ($/Yr)	7,625	6,870	5,010
Present Worth of Operating Cost (x 10.594)	80,780	72,780	53,075
TOTAL PRESENT WORTH[8]	353,000	528,000	558,000

NOTES (TABLE 7)

1. Salvage value of collection system including service lines, but not including STEP Units is taken as 3/5 original value assuming straight line depreciation and 50 year service life.
2. Salvage value of STEP units is taken as 3/5 original value of the pump well and related piping ($900 of $1300 unit cost) which are assumed to have a 50-year service life; the pump and related appurtenances are assumed to have a service life of 20 years and therefore have no salvage value after the 20-year planning period.
3. Salvage value of pump station assumes 1/3 of the cost is for components with a 50-year service life; the remaining 2/3 of the cost is for components having a 20-year service life and therefore has no salvage value.
4. Salvage value of treatment facility is taken as 3/5 construction cost assuming 50-year service life.
5. Salvage value of land is taken as its value after 20 years inflating at a rate of 3% compounded annually.
6. Salvage value is taken as 3/5 original value of collection system (not including pump stations and grinder pump unit) and service lines.
7. Salvage value for grinder pump unit is 3/5 the original value of components having 50 year service life, assuming $1000 original value for these components.
8. Total present worth equals sum of construction, land, and operating cost present worths minus salvage value percent worth; total present worth is rounded to the nearest thousand dollars.

TABLE 8. ANNUAL COST (BASED ON PRESENT POPULATION) -- CORNING (1979 $)

ITEM	ALTERNATIVE I	ALTERNATIVE II	ALTERNATIVE III
	DOLLARS		
CAPITAL COST[1]			
Collection System[2]	303,890	588,970	635,660
Treatment System[3]	58,420	58,420	75,460
Total Capital Cost	362,310	647,390	711,120
Non-Eligible Collection System Costs[4]	24,330	42,480	119,180
Non-Eligible Treatment System Costs[5]	8,220	8,220	11,550
Eligible Collection System Costs	279,590	546,490	516,480
Eligible Treatment System Costs	50,200	50,200	63,910
EPA Funding-Collection System	237,650[8]	464,515[8]	387,360[9]
EPA Funding-Treatment System (75% Grant)	37,650	37,650	47,930
Total EPA Funding	275,300	502,165	435,290
Total Local Share (Total Capital Cost - EPA Funding)	87,010	145,225	275,830
Annual Debt Service[6] (Total Local Share x 0.09439)	8,210	13,710	26,040
OPERATING COST[7]			
Collection System	5,225	5,085	3,510
Treatment System	1,500	1,500	1,500
Total Operating Cost	7,025	6,585	5,010
TOTAL ANNUAL COST (Debt Service and Operating Cost)	15,235	20,295	31,050
ANNUAL COST PER USER (105 USERS)	145/USER	195/USER	295/USER

NOTES (TABLE 8)

1. Capital costs include construction and non-construction costs. Non-construction costs (e.g. engineering fees, legal fees etc) have been assumed to be 27% of construction costs.
2. Collection system cost is determined as follows:
   1.27 x (Collection System Total from Table 5) and House Connection Cost (+ Service Line Cost for Alternative III)
3. Treatment system cost is determined as follows:
   1.27 x (Treatment Facility Cost from Table 5) + Land Cost
4. House connections, service lines, and 30% of non-construction costs are assumed to be non-eligible. Service line cost is eligible for the STEP system alternatives.
5. Land cost and 30% of non-construction costs are assumed to be non-eligible.
6. Based on 20-year period at 7% interest.
7. See Table 6.
8. Assuming 85% grant for "alternative" technology.
9. Assuming 75% grant.

Based on this analysis, the STEP system alternative is the most cost-effective in terms of both present worth and annual cost. In light of the considerable savings that appear to be possible (approximately $200,000 in present worth), the pressure sewer alternative should be further investigated in a detailed Step I facility planning study which would include the preparation of preliminary engineering plans.

ALTERNATIVE SYSTEMS FOR FURLEY

Three alternative systems are evaluated for the Furley Improvement District:

- Alternative I -- Small diameter pressure sewer collection system utilizing individual septic tank effluent pump (STEP) units (i.e., one per user), and a continuously discharging lagoon treatment facility.

- Alternative II -- Small diameter pressure sewer collection system utilizing clustered STEP units (i.e., more than one user per pumping unit), and a continuously discharging lagoon treatment facility.

- Alternative III -- Conventional gravity sewer collection system, and a continuously discharging lagoon (a pump station is included in the lagoon treatment facility).

Two pressure sewer configurations are considered in this case to compare the relative cost of using single STEP units (one per home) as opposed to using clustered STEP units serving more than one home. Alternative I assumes the use of single STEP units while Alternative II considers using clustered units where feasible. The alternative collection system configurations are shown in Figure 4. The location of the treatment facility is the same for all alternatives, and remains as proposed in the facility plan.

The construction and O&M costs are presented in Tables 9 and 10 for both present and future (20 year) population estimates. The present worth costs for the three alternatives are presented in Table 11. These estimates reflect the total construction costs (not including engineering/legal fees, etc.) and operating costs of facilities serving the future design population. The annual cost estimates presented in Table 12 reflect the total capital costs (including engineering/legal fees, etc., and financing of local shares) and operating costs for facilities serving the present population. It is assumed that the cost of

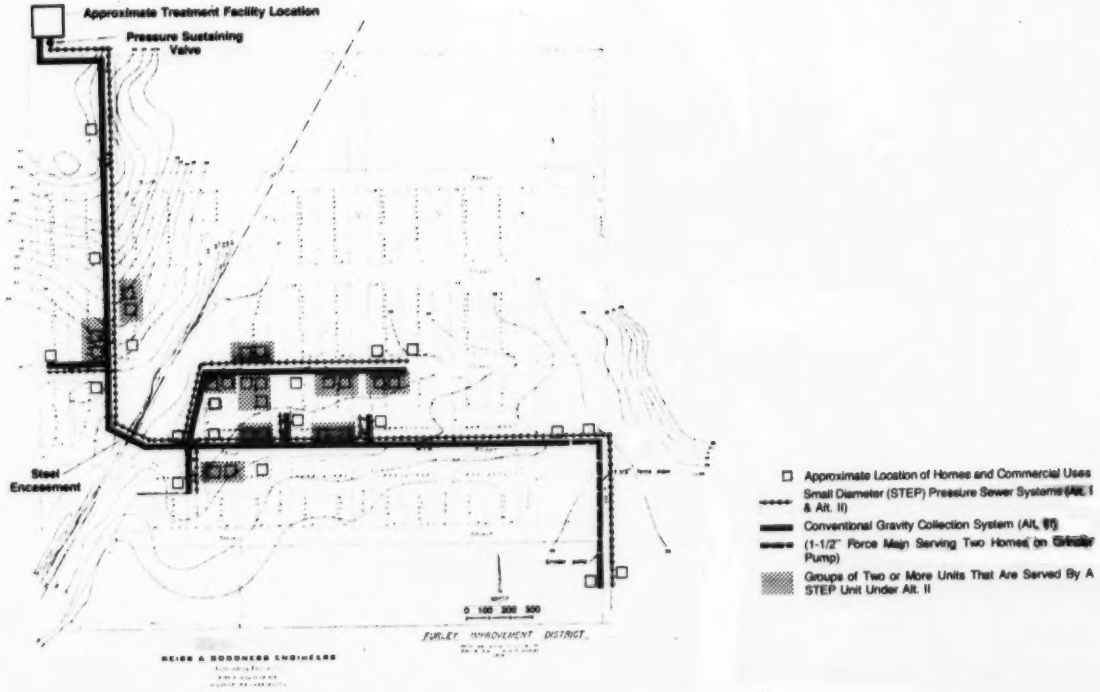
Approximate Treatment Facility Location
Pressure Sustaining Valve
Steel Encasement
Approximate Location of Homes and Commercial Uses
Small Diameter (STEP) Pressure Sewer Systems (Alt. I & Alt. II)
Conventional Gravity Collection System (Alt. II)
(1-1/2" Force Main Serving Two Homes on Grinder Pump)
Groups of Two or More Units That Are Served By A STEP Unit Under Alt. II
0 100 200 300
FURLEY IMPROVEMENT DISTRICT

Figure 4. Collection system alternatives for Furley.

TABLE 9. CONSTRUCTION COSTS[1] - FURLEY (1979 $)

ALTERNATIVE	ITEM	UNIT COST $	PRESENT POPULATION - 40 DWELLINGS QUANTITY	PRESENT POPULATION - 40 DWELLINGS COST $	FUTURE POPULATION - 55 DWELLINGS QUANTITY	FUTURE POPULATION - 55 DWELLINGS COST $
I	1-1/2" PVC Sewer Line	3.75/ft.	1500 ft.	5,625	1500 ft.	5,625
	2" PVC Sewer Line	4.00/ft.	2100 ft.	8,400	2100 ft.	8,400
	2-1/2" PVC Sewer Line	4.25/ft.	400 ft.	1,700	400 ft.	1,700
	3" PVC Sewer Line	4.75/ft.	3000 ft.	14,250	3000 ft.	14,250
	6-5/8" Steel Encasement[2]	30.00/ft.	200 ft.	6,000	200 ft.	6,000
	Pressure Sustaining Valve[3]	1500 each	1	1,500	1	1,500
	STEP Units (Septic Tank, Pump, & Pump Well)	1300 each	40	52,000	55	71,500
	Service Lines (1-14"PVC[4]	3.00/ft.	6000 ft.	18,000	8250 ft.	24,750
	COLLECTION SYSTEM TOTAL			107,475		133,725
	House Connection[5]	50 each	40	2,000	55	2,750
	Treatment Facility (Non-discharging Lagoon)	(see note 6.)	1	47,250	1	47,250
	TOTAL CONSTRUCTION COST			156,725		183,725
	Land	1200/acre	7	8,400	7	8,400
II	1-1/2" PVC Sewer Line	3.75/ft.	1500 ft.	5,625	1500 ft.	5,625
	2" PVC Sewer Line	4.00/ft.	2100 ft.	8,400	2100 ft.	8,400
	2-1/2" PVC Sewer Line	4.25/ft.	400 ft.	1,700	400 ft.	1,700
	3" PVC Sewer Line	4.75/ft.	3000 ft.	14,250	3000 ft.	14,250
	6-5/8" Steel Encasement[2]	30.00/ft.	200 ft.	6,000	200 ft.	6,000
	Pressure Sustaining Valve	1500 each	1	1,500	1	1,500
	STEP Units	1300 each	29[7]	37,700	37[10]	48,100
	Septic Tanks	400 each	11[8]	4,400	18[8]	7,200
	Service Lines (1-1/4" PVC)[9]	3.00/ft.	4000 ft.	12,000	6500 ft.	19,500
	COLLECTION SYSTEM TOTAL			91,575		112,275
	House Connection[5]	50 each	40	2,000	55	2,750
	Treatment Facility (Non-discharging lagoon)	(see note 6.)	1	47,250	1	47,250
	TOTAL CONSTRUCTION COST			140,825		162,275
	Land	1200/acre	7	8,400	7	8,400

TABLE 9. (CONTINUED)

	8" Gravity Sewer	20.00/ft.	6300 ft.	126,000	6300 ft.	126,000
	12" Steel Encasement	50.00/ft.	200 ft.	10,000	200 ft.	10,000
	Grinder Pump Unit	1750 each	1	1,750	1	1,750
	1-1/2" PVC Sewer Line	3.75/ft.	700 ft.	2,625	700	2,625
III	COLLECTION SYSTEM TOTAL			140,375		140,375
	Service Lines (4" Pipe) (4)	5.00/ft.	6000 ft.	30,000	8250 ft.	41,250
	House Connection (5)	50 each	40	2,000	55	2,750
	Treatment Facility (Non-discharging lagoon)	(see note 6.)	1	71,845	1	71,845
	TOTAL CONSTRUCTION COST			244,220		256,220
	Land	1200/acre	14	16,800	14	16,800

NOTES (TABLE 9)

1. Construction costs do not include engineering fees, legal fees, contingencies, or land costs (land costs are shown separately).
2. Steel encasement installed by boring required for railroad crossing.
3. Pressure sustaining valve required to maintain positive pressure in line with negative slope.
4. Assuming 150 feet per connection (from house to street for gravity system and from septic tank to street for STEP system).
5. Connection to house plumbing; includes labor only for gravity sewer system and includes labor plus 4" connection line to septic tank for STEP system.
6. Lagoon costs based on Reiss and Goodness estimate in facility plan; a 50% reduction in lagoon size was assumed in Alternatives I and II to account for solids removed in septic tank.
7. Assuming ten clustered STEP units serving two or three homes each (see Figure 4).
8. Additional tanks for homes connected to a cluster STEP unit (each home has an individual septic tank).
9. Assuming 150 feet per single connection and 100 feet per home in a cluster connection.
10. Assuming 17 clustered STEP units.

TABLE 10. OPERATION AND MAINTENANCE COSTS -- FURLEY (1979 $)

ALTERNATIVE	ITEM	UNIT COST $/YR	PRESENT POPULATION QUANTITY	PRESENT POPULATION COST $/YR	FUTURE POPULATION QUANTITY	FUTURE POPULATION COST $/YR
I	Pressure Sewer Lines	100/Mile	7000 ft.	135	7000 ft.	135
	STEP Units[1]	45/unit	40	1,800	55	2,475
	Septic Tank Pumping[2]	15/unit	40	600	55	825
	Treatment Facility	(see Note 3)	1	1,500	1	1,500
	TOTAL			4,035		4,935
II	Pressure Sewer Lines	100/Mile	7000 ft.	135	7000 ft.	135
	STEP Units[1]	45/unit	29	1,305	37	1,665
	Septic Tank Pumping[2]	15/unit	40	600	55	825
	Treatment Facility	(see Note 3)	1	1,500	1	1,500
	TOTAL			3,540		4,125
III	Gravity Sewer Lines	500/Mile	6300 ft.	600	6300 ft.	600
	Pressure Sewer Lines	100/Mile	700 ft.	15	700 ft.	15
	Grinder Pump	75/unit	1	75	1	75
	Treatment Facility	(see Note 3)	1	1,500	1	1,500
	TOTAL			2,190		2,190

NOTES (TABLE 10)

1. STEP unit O&M costs distributed as follows:

Power	-	3.00/Yr.
Pump Repair	-	20.00/Yr.
Preventive Maintenance	-	12.00/Yr.
Appurtenance Repair	-	10.00/Yr.
		$45.00/Yr.

2. Assuming tank pumped once every four years at a cost of $60.00 per pumping which includes the cost of transporting and disposal.

3. Operation and maintenance costs based on Reiss and Goodness estimate for typical small lagoon.

TABLE 11. PRESENT WORTH COST (BASED ON FUTURE POPULATION) -- FURLEY (1979 $)

ITEM	DOLLARS		
	ALTERNATIVE I (STEP)	ALTERNATIVE II (CLUSTERED STEP)	ALTERNATIVE III (GRAVITY SEWER)
Total Construction Cost	183,725	162,275	256,220
Present Worth of Construction Cost (x1.00)	183,725	162,275	256,220
Land Cost	8,400	8,400	16,800
Present Worth of Land Cost (x 1.00)	8,400	8,400	16,800
Salvage Value of Collection System[1]	37,335	38,500	107,925[5]
Salvage Value of STEP Units[2]	29,700	19,980	600[6]
Salvage Value of Treatment Facility[3]	28,350	28,350	43,100
Salvage Value of Land[4]	15,200	15,200	30,350
TOTAL SALVAGE VALUE	110,585	102,030	181,975
Present Worth of Total Salvage Value (x0.2584)	(28,575)	(26,365)	(47,020)
Total Operating Cost ($/Yr)	4,935	4,125	2,190
Present Worth of Operating Cost (x 10.594)	52,280	43,700	23,200
TOTAL PRESENT WORTH[7]	216,000	188,000	249,000

NOTES (TABLE 11)

1. Salvage value of collection system (including service lines, but not including STEP units) is taken as 3/5 original value assuming straight line depreciation and 50-year service life.

2. Salvage value of STEP units is taken as 3/5 original value of the pump well and related piping ($900 of $1300 unit cost) which are assumed to have a 50-year service life; the pump and related appurtenances are assumed to have a service life of 20 years and therefore have no salvage value after the twenty year planning period.

3. Salvage value of treatment facility is taken as 3/5 construction cost assuming 50-year service life.

4. Salvage value of land is taken as its value after 20 years inflating at a rate of 3% compounded annually.

5. Salvage value includes collection system (not including grinder pump unit) and service lines.

6. Salvage value for grinder pump unit components having 50-year service life; assuming $1000 original value for these components.

7. Total Present Worth equals sum of construction, land, and operating cost present worths minus salvage value present worth; Total Present Worth is rounded to the nearest thousand dollars.

TABLE 12. ANNUAL COST (BASED ON PRESENT POPULATION) -- FURLEY (1979 $)

ITEM	DOLLARS		
	ALTERNATIVE I (STEP)	ALTERNATIVE II (CLUSTERED STEP)	ALTERNATIVE III (GRAVITY SEWER)
CAPITAL COST[1]			
Collection System[2]	138,490	118,300	210,280
Treatment System[3]	68,410	68,410	108,040
Total Capital Cost	206,900	186,710	318,330
Non-Eligible Collection System Costs[4]	10,710	9,420	43,370
Non-Eligible Treatment System Costs[5]	12,230	12,230	22,620
Eligible Collection System Costs	127,780	108,880	166,910
Eligible Treatment System Costs	56,180	56,180	85,420
EPA Funding-Collection System	108,610[8]	92,550[8]	125,180[9]
EPA Funding-Treatment System (75% Grant)	42,135	42,135	64,065
Total EPA Funding	150,745	134,685	189,245
Total Local Share (Total Capital Cost - EPA Funding)	56,155	52,025	129,085
Annual Debt Service[6] (Total Local Share x 0.09439)	5,300	4,910	12,180
OPERATING COST[7]			
Collection System	2,535	2,040	690
Treatment System	1,500	1,500	1,500
Total Operating Cost	4,035	3,540	2,190
TOTAL ANNUAL COST (Debt Service + Operating Cost)	9,335	8,450	14,370
ANNUAL COST PER USER (40 Users)	235/User	210/User	360/User

NOTES (TABLE 12)

1. Capital costs include construction and non-construction costs. Non-construction costs (e.g. engineering fees, legal fees, etc.) have been assumed to be 27% of construction costs.
2. Collection system cost is determined as follows: 1.27 x (Collection System Total from Table 9) + House Connection Cost (+ Service Line Cost for Alternative III)
3. Treatment system cost is determined as follows: 1.27 x (Treatment Facility Cost from Table 9) + Land Cost
4. House connections, service lines, and 30% of non-construction costs are assumed to be non-eligible. Service line cost is eligible for the STEP system alternatives.
5. Land cost and 30% of non-construction costs are assumed to be non-eligible.
6. Based on 20 year period at 7% interest rate.
7. See Table 10.
8. Assuming 85% grant for "alternative" technology.
9. Assuming 75% grant.

individual STEP units, service lines, and house connections for future homes will be absorbed in the cost of the house, and should not be included in the user cost.

In order to determine the impact of greater-than-projected growth on user cost, annual costs were also computed for a future population of 500. This was done for Furley because the potential exists for rapid growth due to its proximity to Wichita, the largest city in Kansas. Any improvement in the form of a sewage collection system is likely to contribute to such growth. Table 13 shows how future growth might affect user costs.

The cost analysis for Furley indicates that the clustered STEP system alternative is the most cost-effective under the assumption of future growth currently projected in the facility plan. However, the conventional gravity sewer alternative becomes relatively more cost-effective with increasing service population. For this reason the true potential for future growth (i.e., 20-year period) in this area should be investigated before choosing the most cost-effective system. If a population of greater than 500 is forecast for the year 2000, conventional gravity sewer collection should be utilized as proposed in the original Facility Plan. Otherwise, preliminary plans for a STEP pressure sewer system should be prepared in a Step I facility planning study.

ALTERNATIVE SYSTEMS FOR HAVANA

Three alternative systems are evaluated for the Havana service area:

- Alternative I -- Small diameter pressure sewer collection system utilizing individual and clustered septic tank effluent pump (STEP) units and a continuously discharging lagoon treatment facility.

- Alternative II -- Small diameter pressure sewer collection system with a STEP system serving approximately half the service area, with the remaining area served by newly constructed on-lot septic tank/drainage field systems, and a continuously discharging lagoon serving the sewered portion of the service area.

- Alternative III -- Conventional gravity sewer collection system with pump station, and continuously discharging lagoon.

TABLE 13. EFFECT OF FUTURE GROWTH ON USER COST IN FURLEY ($)

	Population		
	Present	Future I (pop: 140)	Future II[1] (pop: 500)
Alternative I			
Annual Cost	9,335	10,945	53,640
User Cost	235/yr	199/yr	325/yr[2]
Alternative II			
Annual Cost	8,450	9,615	45,540
User Cost	210/yr	174/yr	276/yr[2]
Alternative III			
Annual Cost	14,370	15,510	55,710
User Cost	360/yr	282/yr	337/yr[2]

[1]The cost estimate for this example assumes double the length of collection line as the Future I case, and three times the number of units (i.e., homes) in Future I.

[2]The user costs are relatively higher in this case since no EPA funding is assumed for the expansion in facilities since this would not be eligible. Note that the range in user costs is much closer, therefore lessening the degree to which Alternatives I and II are more cost-effective.

Individual on-lot systems were considered in Alternative II to illustrate the relative cost of partial sewering. Although soils data for the area indicate conditions unsuitable for subsurface disposal, discussions with Mayor Pittman of Havana indicated that existing systems in the north portion of the community seemed to experience relatively fewer failures. Nonetheless, this alternative is viewed more as a comparative exercise than as a viable system alternative, since the KDHE District Geologist confirms that unsuitable soils prevail throughout the entire service area. The alternative collection systems considered are shown in Figure 5.

Construction costs and O&M costs are presented in Tables 14 and 15 for both present and future (20 year) population estimates. The present worth costs for the three alternatives are presented in Table 16.

These estimates reflect the total construction costs (not including engineering/legal fees, etc.) and operating costs of facilities serving the future design population. The annual cost estimates presented in Table 17 reflect the total capital costs (including engineering/legal fees, etc., and financing of local shares) and operating costs for facilities serving the present population. It is assumed that the cost of individual STEP units, service lines, and house connections for future homes will be absorbed in the cost of the house, and should not be included in the user cost.

The cost analysis proved Alternatives I and II to be most cost-effective in terms of the least present worth cost. However, the combination pressure sewer/on-lot system alternative was found to have the least annual cost due to the lower operation maintenance costs. Nonetheless, the probability of unsuitable soils precludes further consideration of Alternative II. The STEP system alternative would result in considerable savings in terms of both initial capital investment and annual user costs. It is therefore recommended for further detailed study in a Step I facility planning study.

CONCLUSIONS

The conclusions of this study are reflected in the recommendations following the cost analysis for each community in the preceding subsections. It should be noted that in the cases where alternative collection systems are recommended, further engineering would be required to prepare preliminary plans and detailed cost estimates. This study of alternatives does not substitute for a Step I facilities plan.

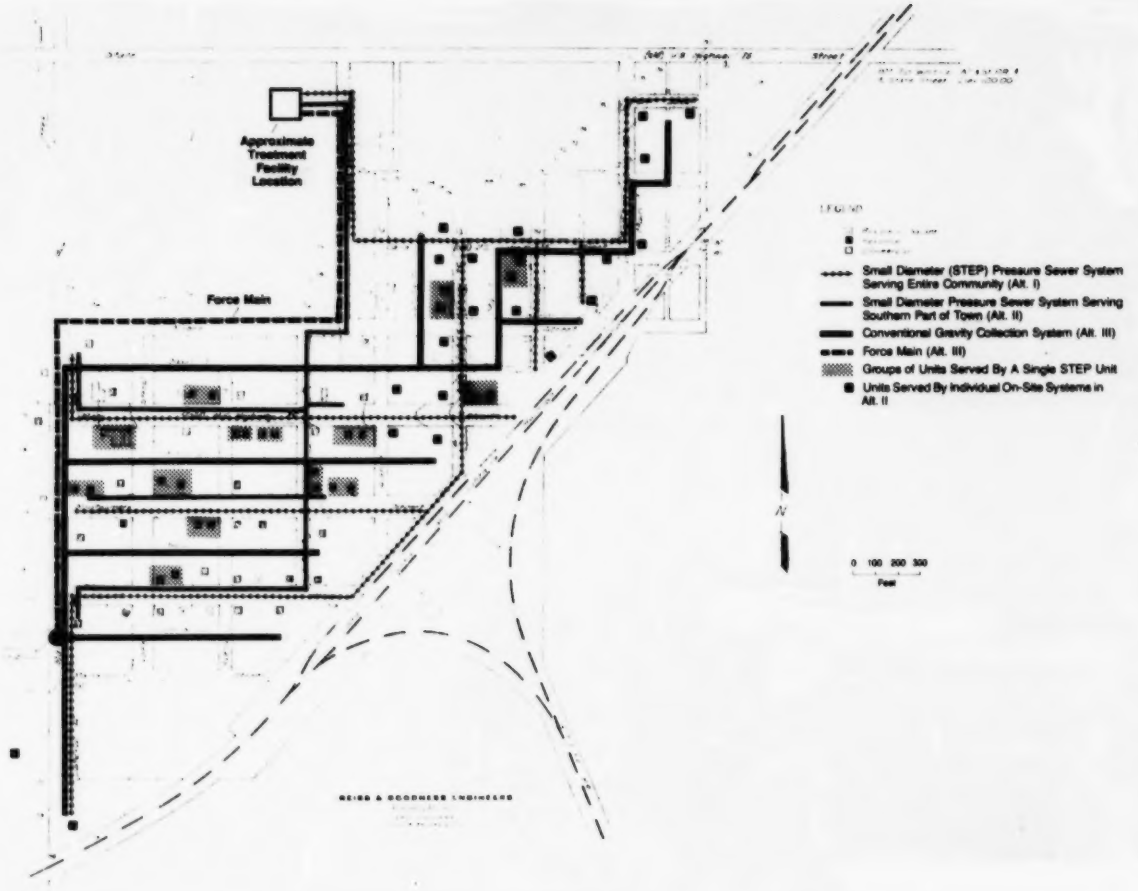
Approximate Treatment Facility Location
Force Main
Small Diameter (STEP) Pressure Sewer System Serving Entire Community (Alt. I)
Small Diameter Pressure Sewer System Serving Southern Part of Town (Alt. II)
Conventional Gravity Collection System (Alt. III)
Force Main (Alt. III)
Groups of Units Served By A Single STEP Unit
Units Served By Individual On-Site Systems in Alt. II
N
0 100 200 300
Feet

Figure 5. Collection system alternatives for Havana.

TABLE 14. CONSTRUCTION COSTS[1] -- HAVANA (1979 $)

ALTERNATIVE	ITEM	UNIT COST $	PRESENT POPULATION - 75 DWELLINGS QUANTITY	PRESENT POPULATION - 75 DWELLINGS COST $	FUTURE POPULATION - 87 DWELLINGS QUANTITY	FUTURE POPULATION - 87 DWELLINGS COST $
I	1 1/2" PVC Sewer Line	3.75/ft.	3900 ft.	14,625	3900 ft.	14,625
	2" PVC Sewer Line	4.00/ft.	4900 ft.	19,600	4900 ft.	19,600
	2 1/2" PVC Sewer Line	4.25/ft.	1000 ft.	4,250	1000 ft.	4,250
	3" PVC Sewer Line	4.75/ft.	800 ft.	3,800	800 ft.	3,800
	4" PVC Sewer Line	5.50/ft.	1500 ft.	8,250	1500 ft.	8,250
	STEP Units (Septic Tank, Pump, and Pump Well)	1300 each	61[7]	79,300	70[10]	91,000
	Septic Tanks	400 each	14[8]	5,600	17[8]	6,800
	Service Lines (1 1/4" PVC)[2]	3.00/ft.	9850 ft.	29,550	11350 ft.	34,050
	COLLECTION SYSTEM TOTAL			164,975		182,375
	House Connection[3]	50 each	75	3,750	87	4,350
	Treatment Facility (Discharging Lagoon)	(see Note 5)	1	33,225	1	33,225
	TOTAL CONSTRUCTION COST			201,950		219,950
	Land	1200/acre	3	3,600	3	3,600
II	1 1/2" PVC Sewer Line	3.75/ft.	1300 ft.	4,875	1300 ft.	4,875
	2" PVC Sewer Line	4.00/ft.	2400 ft.	9,600	2400 ft.	9,600
	2 1/2" PVC Sewer Line	4.25/ft.	800 ft.	3,400	800 ft.	3,400
	3" PVC Sewer Line	4.75/ft.	1800 ft.	8,550	1800 ft.	8,550
	STEP Units	1300 each	37[9]	48,100	41[11]	53,300
	Septic Tanks	400	11[8]	4,400	13[8]	5,200
	Service Lines (1 1/4" PVC)[2]	3.00/ft.	6100 ft.	18,300	6800 ft.	20,400
	On-site Systems[4]	3000 each	27	81,000	33	99,000
	COLLECTION SYSTEM TOTAL			178,225		204,325
	House Connection[3]	50 each	48	2,400	54	2,700
	Treatment Facility (Discharging Lagoon)	(see Note 5)	1	31,965	1	31,965
	TOTAL CONSTRUCTION COST			212,590		238,990
	Land	1200/acre	3	3,600	3	3,600

TABLE 14. (CONTINUED)

	8" Gravity Sewer	20.00/ft.	10900 ft.	218,000	10,900 ft.	218,000
	4" Force Main	5.50/ft.	4000 ft.	22,000	4,000 ft.	22,000
	Pump Station	(see Note 6)	1	17,000	1	17,000
III	COLLECTION SYSTEM TOTAL			257,000		257,000
	Service Lines (4" Pipe)(2)	5.00/ft.	11250 ft.	56,250	13,050 ft.	65,250
	House Connection(3)	50 each	75	3,750	87	4,350
	Treatment Facility (Discharging Lagoon)	(see Note 5)	1	39,997	1	39,997
	TOTAL CONSTRUCTION COST			356,997		366,597
	Land	1200/acre	5	6,000	5	6,000

NOTES (TABLE 14)

1. Construction costs do not include engineering fees, legal fees, contingencies, or land costs (land costs are shown separately).

2. Service line includes line from house to street lateral in a gravity system, and the line from the STEP unit to street lateral. Assume 150 feet per single connection and 100 feet per home in a cluster connection.

3. Connection to house plumbing; includes labor only for gravity sewer system and includes labor plus 4" connection line to septic tank for STEP system. House connection costs do not apply to on-site systems.

4. On-site systems are included with collection system costs since the cost of septic tank-drainfield systems (i.e., replacement of existing systems with modified on-site systems) would be eligible for EPA funding and would also incur non-construction costs such as engineering and legal fees.

5. Lagoon costs based on Reiss and Goodness estimate in facility plan; a reduction in lagoon size was assumed in Alternatives I (50% reduction) and II (68% reduction) to account for solids removed in septic tank and systems not connected to lagoon.

6. Pump station cost based on Reiss and Goodness estimate.

7. Assuming 14 clustered STEP units serving two homes each (see Figure 5).

8. Additional tanks for homes connected to a cluster STEP unit (each home has an individual septic tank).

9. Assuming 11 clustered STEP units.

10. Assuming 17 clustered STEP units.

11. Assuming 13 clustered STEP units.

TYPING GUIDE SHEET

TABLE 15. OPERATING AND MAINTENANCE COSTS -- HAVANA (1979 $)

ALTERNATIVE	ITEM	Unit Cost $	PRESENT POPULATION QUANTITY	PRESENT POPULATION COST $	FUTURE POPULATION QUANTITY	FUTURE POPULATION COST $
I	Pressure Sewer Lines	100/mile	12100 ft.	230	12100 ft	230
	STEP Units(1)	45/unit	61	2,745	70	3,150
	Septic Tank Pumping(2)	15/unit	75	1,125	87	1,305
	Treatment Facility	(see Note 3)	1	1,500	1	1,500
	TOTAL			5,600		6,185
II	Pressure Sewer Lines.	100/mile	6300 ft.	120	6300 ft.	120
	STEP Units(1)	45/unit	37	1,665	41	1,845
	Septic Tank Pumping(2)	15/unit	75	1,125	87	1,305
	Treatment Facility	(see Note 3)	1	1,500	1	1,500
	TOTAL			4,410		4,770
III	Gravity Sewer Lines	500/mile	10900 ft.	1,030	10900 ft	1,030
	Force Main	100/mile	4000 ft.	75	4000 ft.	75
	Pump Station	800 each	1	800	1	800
	Treatment Facility	(see Note 3)	1	1,500	1	1,500
	TOTAL			3,405		3,405

NOTES (TABLE 15)

1. STEP unit O&M costs distributed as follows:

Power	-	3.00/Yr.
Pump Repair	-	20.00/Yr.
Preventive Maintenance	-	12.00/Yr.
Appurtenance Repair	-	10.00/Yr.
		$45.00/Yr.

2. Assuming tank pumped once every four years at a cost of $60.00 per pumping which includes the cost of transporting and disposal.

3. Operation and maintenance costs based on Reiss and Goodness estimate for typical small lagoon.

TABLE 16. PRESENT WORTH COST (BASED ON FUTURE POPULATION) -- HAVANA (1979 $)

ITEM	DOLLARS		
	ALTERNATIVE I (STEP)	ALTERNATIVE II (CLUSTERED STEP)	ALTERNATIVE III (GRAVITY SEWER)
Total Construction Cost	219,950	238,990	366,597
Present Worth of Construction Cost (x 1.00)	219,950	238,990	366,597
Land Cost	3,600	3,600	6,000
Present Worth of Land Cost (x 1.00)	3,600	3,600	6,000
Salvage Value of Collection System[1]	54,825	90,615[6]	183,150[6]
Salvage Value of STEP Units[2]	37,800	22,140	-
Salvage Value of Pump Station[3]	-	-	3,400
Salvage Value of Treatment Facility[4]	19,935	19,180	24,000
Salvage Value of Land[5]	6,500	6,500	10,840
TOTAL SALVAGE VALUE	119,060	138,435	221,390
Present Worth of Total Salvage Value (x 0.2584)	(30,765)	(35,770)	(57,210)
Total Operating Cost ($/Year)	6,185	4,770	3,405
Present Worth of Operating Cost (x 10.594)	65,520	50,535	36,070
TOTAL PRESENT WORTH[7]	258,000	257,000	351,000

NOTES (TABLE 16)

1. Salvage value of collection system (including service lines, but not including STEP units) is taken as 3/5 original value assuming straight line depreciation and 50-year service life.

2. Salvage value of STEP units is taken as 3/5 original value of the pump well and related piping ($900 of $1,300 unit cost) which are assumed to have a 50-year service life; the pump and related appurtenances are assumed to have a service life of 20 years and, therefore, have no salvage value after the 20-year planning period.

3. Salvage value of pump station assumes 1/3 of the cost is for components with a 50-year service life; the remaining 2/3 of the cost is for components having a 20-year service life and, therefore, has no salvage value.

4. Salvage value of treatment facility is taken as 3/5 construction cost assuming 50-year service life.

5. Salvage value of land is taken as its value after 20 years, inflating at a rate of 3% compounded annually.

6. Salvage value is taken as 3/5 original value of collection system (not including pump station) and service lines.

7. Total present worth equals sum of construction, land, and operating cost present worths minus salvage value present worth; total present worth is rounded to the nearest thousand dollars.

TABLE 17. ANNUAL COST (BASED ON PRESENT POPULATION) -- HAVANA (1979 $)

ITEM	ALTERNATIVE I (STEP)	ALTERNATIVE II (CLUSTERED STEP)	ALTERNATIVE III (GRAVITY SEWER)
	----------DOLLARS----------		
CAPITAL COST[1]			
Collection System[2]	213,270	228,745	386,390
Treatment System[3]	45,800	44,195	56,800
Total Capital Cost	259,070	272,940	443,190
Non-Eligible Collection System Costs[4]	17,115	16,835	80,820
Non-Eligible Treatment System Costs[5]	6,290	6,190	9,240
Eligible Collection System Costs	196,155	211,910	305,570
Eligible Treatment System Costs	39,510	38,005	47,560
EPA Funding-Collection System	166,730	180,125	229,180
EPA Funding-Treatment System (75% Grant)	29,635	28,505	35,670
Total EPA Funding	196,365	208,630	264,850
Total Local Share (Total Capital Cost - EPA Funding)	62,705	64,310	178,340
Annual Debt Service[6] (Total Local Share x 0.09439)	5,920	6,070	16,835
OPERATING COST			
Collection System	4,100	2,910	1,905
Treatment System	1,500	1,500	1,500
Total Operating Cost	5,600	4,410	3,405
TOTAL ANNUAL COST (Debt Service + Operating Cost)	11,520	10,480	20,240
ANNUAL COST PER USER (75 Users)	155/User	140/User	270/User

NOTES (TABLE 17)

1. Capital costs include construction and non-construction costs. Non-construction costs (e.g. engineering, legal fees, etc.) have been assumed to be 27% of construction costs.

2. Collection system cost is determined as follows:
   1.27 x (Collection System Total from Table 14) + House Connection Cost + (Service Line Cost for Alternative III)

3. Treatment system cost is determined as follows:
   1.27 x (Treatment Facility Cost from Table 14) + Land Cost

4. House connections, service lines, and 30% of non-construction costs are assumed to be non-eligible. Service line cost is eligible for the STEP system alternatives.

5. Land cost and 30% of non-construction costs are assumed to be non-eligible.

6. Based on 20-year period at 7% interest rate.

7. See Table 15.

8. Assuming 85% grant for "alternative" technology.

9. Assuming 75% grant.

The underlying issue in this study relates to economic impact on the users. Discussions with local representatives[1] indicated that residents were both willing and able to pay the user costs projected in the facility plans. Using the guidelines provided in the U.S. EPA PRM 79-8 regarding economic impact, only Corning appears to have excessive costs (Table 18). In the case of Corning, other funding sources have been secured (HUD grant) which considerably reduce the local share of capital costs (see Table 1) and the resulting user costs. The economic impact on users in all three communities appears to depend on the ultimate service population. As the service population increases, the user cost is reduced, especially for conventional gravity sewer systems. Therefore, future growth and its relationship to the provision of sewerage system improvements should be considered in evaluating economic impact.

The total feasibility of the pressure sewer system in these particular situations should not be based solely on cost-effectiveness. Two other important factors relate to: 1) the capability of the community to manage (i.e., operate day-to-day) a STEP collection system, and 2) the impact of conditions resulting from prolonged power outages.

It is felt that a part-time employee, or city resident would be capable of serving the maintenance needs of the proposed systems, with limited training. The periodic maintenance of septic tanks (i.e., tank pumping every 3 or 4 years) could probably be arranged through private septage haulers.

The question concerning the effect of prolonged power outages appears to be a valid one. Very severe storms in the past have caused power outages for as long as several weeks in this area.[2] This obviously would exceed the emergency storage capacity designed into a typical STEP system. Although certain temporary solutions could be applied (e.g., emergency power source, or hauling of wastes by truck), frequent occurrence of such outages would seriously detract from the feasibility of this alternative.

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[1]Mayor Dallas Pittman in Havana; Richard Potter, Chairman of the Board for the Furley Improvement District.
[2]Conversation with Mayor Dallas Pittman of Havana.

TABLE 18. RELATIVE ECONOMIC IMPACT[1] ($)

	Estimated User Cost	1975[2] Per Capita	Median[3] Household Income	Excessive Limit $/yr
Corning				
Alternative I	145			
Alternative II	195	1,968	4,509	68
Alternative III	295			
Furley				
Alternative I	325			
Alternative II	276	-	17,100	427
Alternative III	337			
Havana				
Alternative I	155			
Alternative II	140	3,555	14,355	359
Alternative III	270			

[1]Based on guidance in PRM 79-8, user cost is considered excessive if the annual cost exceeds:

1.5 percent of household income (median income less than $6,000/yr.)
2.0 percent of household income (median income $6,000/$10,000/yr.)
2.5 percent of household income (median income greater than $10,000/yr.)

[2]Population Estimates and Projections, U.S. Bureau of the Census, January 1979.

[3]For Furley from Wichita County Annual Intergovernmental Enumeration, 1978; For Havana and Corning estimated by adjusting per capita income to 1980 and multiplying by number of persons per household.

It is therefore recommended that construction of pressure sewer systems be considered, provided assurances can be made by U.S. EPA that this application of alternative technology qualifies for 100 percent reimbursement in the event that recurring power outages prevent proper operation of the system. Reimbursement cannot be sought if system failure results from improper design, construction, or use.

Obviously, many factors determine the true feasibility of a collection and treatment system alternative. This was very evident in the study of these three communities, and is reflected in the recommendations for each community offered in this report.

APPENDIX A

SOILS INFORMATION

BACKGROUND

The soils found around the three communities of Havana, Furley, and Corning, Kansas have developed from glacial till, shale and sandstone bedrock, and water-deposited material (alluvium). The physical characteristics of the soils identified around these communities vary. The physical characteristics of the soils are listed in Tables A-1, A-2, and A-3.

The soils around Corning in Nemaha County developed in glacial till and water-deposited material. The soils identified around Corning are the Pawnee, Burchard, and Kennebec soils (Table A-1). The Pawnee and Burchard soils are deep, well-drained soils which developed in glacial till. These glacial soils are slowly permeable due to clayey subsoils. The Kennebec soil is a flood plain soil which is deep and moderately well-drained. The Kennebec is moderately permeable.

The soils found around the Furley area developed in old and recent alluvium and from shale bedrock. The soils identified around Furley are the Tabler, Irwin, Clime, Elandco, Rosehill, and Goessel series (Table A-2). The Clime and Rosehill soils have developed from shale bedrock. However, the Clime soil is shallow, while the Rosehill is deep. Both soils are well-drained and are slowly permeable. The Tabler soil is moderately well-drained and deep, while Irwin and Goessel soils are well-drained and deep. All three of these soils formed in old alluvium along ream terraces. The Elandco soil formed in recent alluvium and is subject to flooding approximately every three years. All the soils around Furley have silty clay or clay subsoils, and are very slowly permeable. These soils also contain montmorillonite to varying degrees, and have moderate to severe shrink-swell potential.

The soils found around Havana in Montgomery County, Kansas are the Woodson, Kenoma, Bates-Collinsville complex, and Kennebec series (Table A-3). The Woodson and Kenoma soils developed in old alluvium. The Woodson soil is moderately well-drained, while the Kenoma soil is well-drained. Both soils are

TABLE A-1. SOILS INFORMATION -- CORNING

Soil Series	Soil Solum (inches)	Depth To Water (feet)	Soil Permeability (in./hr)	Depth To Bedrock (inches)	Soil Texture	Shrink/Swell Potential	Parent Material
FIB Pawnee	10-50	>6.0	.6-2.0 .2-0.6 .2-0.6	>60	l,cl c	Low - High	Glacial till
3D Burchard	10-40	>6.0	.6-2.0 .2-0.6	>60	l,cl	Mod.	Glacial till
IM4 Kennebec	--	1.5-5	.6-2.0	>60	sil, sicl	Mod.	Alluvium

TABLE A-2. SOILS INFORMATION -- FURLEY

Soil Series	Soil Solum (inches)	Depth To Water (feet)	Soil Permeability (in./hr)	Depth To Bedrock (inches)	Soil Texture	Shrink/Swell Potential	Parent Material
Ta Tabler	20-40	perched 2.5-3.5	.2-0.6 .06	>60	sicl, sic c, sicl	Low - High	
Ia Irwin	20-40	>6.0	.2-2.0 .06	>40	sicl, sic c, sic	Mod. - High	
Ce Clime	8-26	>6.0	.06-.6	24	sic, c, sicl	Mod.	
Ec Elandco	20-40	>6.0	.6-2.0	>60	sil, sicl cl, sil	Mod.	
Rd Rosehill	20-30	>6.0	<0.06	30	sic, c	High	Shale
Gb Goessel		>6.0	<0.06	>60	sic, c	High	Old Alluvium

TABLE A-3. SOILS INFORMATION -- HAVANA

Soil Series	Soil Solum (inches)	Depth To Water (feet)	Soil Permeability (in./hr)	Depth To Bedrock (inches)	Soil Texture	Shrink/Swell Potential	Parent Material
FIA Woodson	10-40	.5-2.5	< .06	> 60	cl, c	High	Old Alluvium
F3B Kenoma	20-40	> 6.0	< .06	> 60	sic,c	High	Old Alluvium
41B Bates-Collinsville	--	> 6.0	.6-2.0		fsl,l		Sandstone
IM4 Kennebec	10-40	2-5	.6-2.0 .6-2.0	> 60	sil, sicl	Mod.	Alluvium

deep and have clayey or silty clay subsoils. The soils contain montmorillonite, and therefore, have a high shrink-swell potential. The montmorillonite clay and its high percentage in the subsoil of the Woodson and Kenoma makes these soils very slowly permeable.

The Bates-Collinsville soil complex consists of shallow and moderately deep soils, which developed on sandstone bedrock. These soils are well-drained and have fine sandy loam or loam textures. The Bates and Collinsville soils are moderately permeable. The Kennebec soil is a deep, moderately well-drained soil found on flood plains of streams. The Kennebec soil has a silt loam surface with a silty clay loam subsoil and is moderately permeable. The soil also has a moderate shrink-swell potential.

ON-LOT WASTE DISPOSAL SUITABILITY

The suitability of a soil for on-lot waste disposal is dependent upon several soil characteristics. The characteristics are:

1. Soil texture.
2. Soil permeability.
3. Soil thickness and depth to bedrock.
4. Depth to seasonal high-water table.
5. Slope.
6. Flooding hazard.

An evaluation of the above soil characteristics for each of the soils around the three municipalities was conducted for on-lot waste disposal suitability.

The soils around Havana, Corning, and Furley are unsuitable for typical on-lot waste disposal methods. The most limiting soil characteristic for the three municipalities is soil permeability. All of the nonflood-prone soils are very slowly or slowly permeable and will not readily percolate sewage effluent. The slow soil permeability is due to the high clay content of the soil subsoil and the montmorillonite clay content. Other soil characteristics, such as depth to bedrock, rock, slope, etc., either are not problems or can be overcome by engineering design changes.

APPENDIX B

SUMMARY OF CURRENT OPERATING EXPERIENCE WITH ALTERNATIVE COLLECTION SYSTEMS

TABLE B-1. SUMMARY OF CURRENT OPERATING EXPERIENCE WITH ALTERNATIVE SYSTEMS

Community/Location	Type of System(s)[1]	No. Units	Operational[2] Status	Principal Contact	Comments
Westboro, WI	SDGE	70	1977	Richard Otis University of Wisconsin	Has total management concept, Developed through U. of Wisconsin
Albany, NY	GP, GS	12	1972	-	EPA demonstration project (EPADP)
Phoenixville, PA	GP	-	1972	-	EPADP
Grandview Lake, IN	GP, STEP	100 (28-STEP)	1970 (oldest demonstration project)	Freese & Abplanalp Franklin, IN	EPADP maintenance performed by equipment vendor. No centralized responsibility for repair
Bend, OR	GP, STEP, VS	12-STEP 12-VS	1977	C & G Engineers Salem, OR	EPADP
Glide-Idleyld Park, OR	STEP	600	1978	W. Bowne Douglas Co., OR	Sophisticated STEP system with County ownership and management
Black Butte, OR	gravity-STEP	400	1977	Century West Eng. Bend, OR	-
Apple Valley Lake, OH (Mt. Vernon, OH)	GP	50 225 planned	1973	M. Malcolm Bowen Super. Knox Co. Sewer Water District	Lakefront property served by pressure system
Klaus System-Portland, OR	GP, (houseboat)	25 marina	1968	Gary Klaus Portland, Oregon	No centralized management. Pumps are owned individually and service is responsibility of owner.
Kappas Marina, Sausalito, CA	GP, (houseboat)	8?	1976	Dave Steckler Marina owner	Marina owner maintains collection system while homeowners maintain pumps. (Homeowners free to contact service agents of their own choice)

TABLE B-1. (CONTINUED)

Community/Location	Type of System(s)[1]	No. Units	Operational[2] Status	Principal Contact	Comments
Lake Mohawk, OH (Malvern, OH)	GP	225/ 1700	1974	Friedl & Harris Inc. N. Canton, OH	Pump manufacture has O & M contract for collection system and pumps
Seabrook, TX (Galveston Bay)	GP	22 3-duplex	1977	Don Badeaux City Administrator	Municipal maintenance staff
Point Venture, TX (near Austin, TX)	GP	37	1972	Assoc. Eng. Houston, Texas	Recreational development with one system operator. Pump repair done by local manufacturer
Fair Play, SC (Chickasaw Point Project)	GP	601/ 1700 planned	1974	Mr. Gary See, V.P. Ruswood, Inc.	Initial series of grinder pumps installed 1974
Priest Lake, ID (Coolin & Kalispell, ID)	STEP	548	1972	Mr. Chris Warren District Manager	O & M contracted to private service company
Radcliff, KY	PS	42	1967	-	-
Cuyler, NY (Cortland Co., NY)	GP, PS	39	1977	Jim Feuss Cortland (NY) Co. Health Department	Planning and construction initiated by County Dept. of Health. Service provided by town employee and fees paid through tax assessments
Port Charlotte & Port St. Lucie, FL	STEP, GS	Lucie-200 Charl. 50	P. Charl. - 1970	Mr. Harold E. Schmidt, President, General Development Utilities, Inc.	Private utility owns and operates system through service contract with homeowner
Horseshoe Bay (Lake Lyndon B. Johnson, TX)	GP, PS	200/4000	1971	Jim Lemming System Operator	O & M responsibility is with homeowner through private contractors

TABLE B-1. (CONTINUED)

Community/Location	Type of System(s)[1]	No. Units	Operational[2] Status	Principal Contact	Comments
Lake Meade, PA	GP	220	1978	Carl Brothers Lake Meade, PA	System and pumps owned and maintained by authority
Quaker Lake, PA	GP	110/145	1976	Milnes Engineers Tunkhannock, PA	Similar to Lake Meade. System installation done by homeowner
Lake Winona, PA	GP	40/4000	1976	E. Hess & Assoc. Stroudsburg, PA	-
Weatherby Lake, MO	GP	360 900 planned	1975	Glen Gray Larkin Assoc. Kansas City, MO	Unique O & M contract with maintenance personnel
Saratoga, NY	GP	-	-	City Engineer Saratoga, NY	-
Clifton Park, NY (County Knolls South Development)	GP	355 510 planned	1972	Robert Van Patten Developer	Pump repair done by nearby vendor/ manufacturer. Homeowner pays contractor by service call. (Pump owned by individual, collection system owned by development)
Kinnelon, NJ	GP	-	-	-	-
Diamond Head, Tulsa, OK	GP	-	1972	K.N. Cox & Assoc. Tulsa, OK	-
Southern Hills Estates Sellersburg, IN	GP	23/225	1973	-	-
Strongsville, OH	GP	18	1974	-	-
Thunderhead Lake, (Unionville, MO)	GP	25/300	1974	N.E. Isaacson Reedsburg, WI	-

TABLE B-1. (CONTINUED)

Community/Location	Type of System(s)[1]	No. Units	Operational[2] Status	Principal Contact	Comments
Pogulusa, LA	GP	30	1976	-	-
Rome City, IN	GP	120	1976	John Snell Engineers Lansing, MI	-
Harbor Springs, MI	GP	84/2200	1975	Williams & Works Grand Rapids, MI	-
Lake Lakengren, OH	GP	80/300	1975	M. M. Schutzinger & Assoc., Chillicothe, OH	-
New Landings of the Delta Queen, Dixon, IL	GP	12/2200	1973	W. Hoffman Engineers Dixon, IL	-
Arrowhead Estates, TX	GP	10/100	1974	Bidds & Mathews Wichita Falls, TX	-
South Seas Plantation Captiva, FL	GP	33/60	1977	Johnson Engineers Fort Myers, FL	Had vacuum sewers-changed to GP
San Angelo, TX	GP	160/1250	1976	Water Dept. City of San Angelo, TX	-
Cavalier Lake, MS	GP	81	1976	Reynolds Eng. Inc. Jackson, MI	-
Wexford Co., MI	GP	225	1978	J. Snell Eng. Lansing, MI	-
Mast Hope, PA	GP	150/1000	1976	E. Hess & Assoc. Stroudsburg, PA	-
Montgomery City M.U.D.	GP	25	1975	S & B Eng. Houston, TX	-

TABLE B-1. (CONTINUED)

Community/Location	Type of System(s)[1]	No. Units	Operational[2] Status	Principal Contact	Comments
Winter Green Resort, Nelson & Augusta Cities, VA	GP	50/250	1975	Willey & Wilson Lynchburg, VA	-
Lake Monticello, Fluwanna City, VA	GP	60/200	1975	Gilbert Clifford & Assoc. Fredericksburg, VA	-
Beaver Lake, OH	GP	70/1800	1973	Hendrick, Lox & Assoc. Cleveland, OH	-
Pewaukee Lake, WI	GP	50	1977	-	-
Lake of the Woods Indianapolis, IN	GP	20/120	1977	-	-
Campbell Ave., Systems Schenectady, NY	GP	23	1973	City Eng. Office Schenectady, NY	-
Limestone Hills Sewer District, Fayetteville, NY	GP	12	1973	Calo. Cerino & Spina Liverpool, NY	-
Busch Properties Williamsburg, VA	GP	20	1975	Langley, McDonald & Overman	-
Lake of the Pines, PA	GP	13	1976	-	-

NOTES

1. Collection system.

   GP -- Grinder pump pressure sewer

   GS -- Conventional gravity sewer

   PS -- Pressure sewer

   SDGE -- Small diameter gravity effluent sewer

   STEP -- Septic tank effluent pump pressure sewer

   VS -- Vacuum sewer

2. Date system went into operation.

APPENDIX C

UNIT COST SUMMARY

UNIT COST INFORMATION (1979 $)

ITEM	SIZE	TOTAL INSTALLED UNIT COST ($)	O&M ($/YR)	UNIT COST REFERENCE NUMBER
Gravity Sewer				
	4"	15.00/FT	500/MI	1,2
	8"	20.00/FT		3
	4" Service Conn.	5.00/FT		3
Pressure Sewer				
(PVC)	1-1/4"	3.00/FT	100/MI	3,2
	1-1/2"	3.75/FT		3
	2"	4.00/FT		3
	2-1/2"	4.25/FT		3
	3"	4.75/FT		3
	4"	5.50/FT		6
Conventional Septic Tank/Soil Absorption System (installed)		3,000	15	4
STEP System installed (w/septic tank)		1,300	45/system (not incl. tank pumping)	5,6
STEP Pump		400	-	6
Grinder Pump		1,750	75	5
Pump Station		-	800	7

UNIT COST REFERENCES

1. Kreissl, James F., et al, "The Cost of Small Community Wastewater Alternatives", August, 1978.

2. "Areawide Assessment Procedures Manual: Volume III", EPA-600/9-76-014, Municipal Environmental Research Laboratory, Cincinnati, Ohio, July, 1976.

3. Conversation with Maurice Dingler, Reiss and Goodness Engineers, Wichita, Kansas.

4. Conversation with Steve Innes, Sedgewick County Health Department, Wichita, Kansas.

5. Arthur Beard Engineers, Washington, D.C.

6. WESTON Cost Estimate.

7. Analysis of Operations and Maintenance Costs for Municipal Wastewater Treatment Systems, U.S. EPA (MCD-39), May 1978.